BODY DRYER

Field of the Invention

This invention relates to a body dryer for drying a person's body after bathing or showering or the like.

Background Art

As is well known, the conventional technique for drying oneself is by use of towels. Warm air from conventional heaters is also occasionally used, but does not provide an efficient method of drying.

Summary of the Invention

The object of the invention is to provide a body dryer which can efficiently dry a person.

The invention, in a first aspect, provides a body dryer including:

a housing defining an air chamber;

a narrow elongate outlet aperture in the housing;

heating means for heating air in the housing; and

an air blower for supplying air into the housing for heating by the heating means and for discharge through the narrow elongate air outlet aperture so as to form a blade of hot air flowing outwardly of the housing for wrapping around a person standing in proximity to the housing to dry the person.

The creation of the narrow blade which wraps around the person provides extremely efficient drying characteristics because the elongate outlet generally confines the discharged air to a narrow blade of air, which is confined in a buttressing layer of cooler air. The hot central blade within the buttress of cooler air wraps around a person's body, thereby efficiently transferring heat to the person's body to dry the wet body with a minimum waste loss of energy to the surrounding air.

Preferably the housing is an elongate housing having a longitudinal axis which is intended to be arranged substantially vertical when the dryer is installed for use, the housing having a length in the direction of the longitudinal axis of between 1000 mm and 2000 mm.

Preferably the length of the housing is about 1500 mm.

Preferably the air outlet aperture comprises a segmented slit extending in the direction of the longitudinal axis of the housing.

However, in other embodiments, the outlet aperture may comprise a continuous slit.

Preferably the heating means comprises at least one coiled heating element arranged substantially parallel to the outlet aperture and supported in the housing so that the outlet aperture is spaced from the heating element.

Preferably two coiled heating elements are provided, the coiled heating elements being arranged one behind the other relative to the outlet aperture.

Preferably the air blower comprises a fan, the housing having an air inlet at a lower portion of the housing, and the fan being disposed adjacent the air inlet for drawing air into the housing, which air can flow over the heating elements and then, due to pressurisation within the housing, exits the outlet aperture in the form of a narrow blade of hot air within an envelope of cooler air that then draws a further layer of buttressing cool external air, so that the buttressing layer of cooler air supports the central blade of hot air as the central blade of hot air flows away from the housing.

Preferably the dryer includes air flow control means for converting a vortex flow of air created by the fan into a substantially laminar flow of air.

Preferably the air flow control means comprises a pair of wings arranged downstream of the fan, each wing in the pair of wings being curved in a direction generally opposite to one another so that the vortex air flow created by the fan impinges on the wings and is straightened by the wings into a substantially laminar flow of air, which then flows through housing and over the heating means and out through the outlet aperture.

Preferably each heating element comprises a said coil of wire supported on a central insulating strip.

Preferably the heating element includes a plurality of support means arranged along the length of the coiled heating element, for supporting the coiled heating element to prevent the coiled heating element coils from simply collapsing or compacting when the housing is arranged in a vertical disposition for use.

Preferably the fan is arranged within an outer fan housing, an inner fan housing containing a motor for rotating the fan located in the outer housing and spaced from the outer housing, the wings extending from the inner housing to the outer housing, an opening in the inner housing so that air can pass into the opening, a secondary fan within the inner housing for drawing air into the inner housing through the opening to flow over the motor to cool the motor, and an outlet for returning the air from the inner housing to the exterior of the inner housing.

The inner housing may include an abutment adjacent the opening for directing air blown by the fan into the

opening, and therefore into the inner housing to thereby facilitate the drawing of air into the inner housing by the secondary fan.

Preferably each support means for supporting the coiled element comprises a first card portion having a profiled edge, a second card portion having a profiled edge, so that when the first card portion and second card portion are brought together, the profiled edges define apertures through which both the coil and the central support strip can extend, and with the card portions adjacent the apertures forming support surfaces for holding the coiled element to prevent the coiled element from collapsing vertically under its own weight when the body dryer is installed in a vertical position for use.

Preferably the card portions, and therefore the coiled heating element, is supported in a support frame fixed in the housing.

Preferably the support frame comprises a generally U-shaped section in which the card portions and heating element are received, and a lid section for coupling to the U-shaped section and for holding the card portions, and therefore the heating elements within the frame.

Preferably the dryer includes a control panel section, the control panel section comprising at least one light conductor, a interface at one end of the light conductor, against which the user's fingers can locate, so as to change the nature of light reflected from the interface back through the light conductor to thereby provide a control signal for operating the dryer. This therefore enables the device to be operated without the user coming into contact with any component to which electricity is supplied, so as to eliminate any possibility of a wet body contacting an electrically charged component of the dryer.

A further aspect of the invention is concerned with the provision of a fan assembly for providing air into a body dryer.

This aspect of the invention may be said to reside in a body dryer including:

a housing;

heating means in the housing for heating air in the housing;

an outlet aperture for discharge of air from the housing; and

a fan assembly for supplying air to the housing, including:

(a) a fan;

(b) a motor for driving the fan; and

(c) at least one pair of air flow control wings downstream of the fan for converting vortex or rotating flow of air created by the fan into a laminar flow of air.

Preferably the heating means comprises at least one coiled heating element arranged substantially parallel to the outlet aperture and supported in the housing so that the outlet aperture is spaced from the heating element.

Preferably two coiled heating elements are provided, the coiled heating elements being arranged one behind the other relative to the outlet aperture.

Preferably the housing has an air inlet at a lower portion of the housing, and the fan being disposed adjacent the air inlet for drawing air into the housing, which air can flow over the heating elements and then, due to pressurisation within the housing, exit the outlet aperture in the form of a narrow blade of air which draws a buttressing layer of cooler air, so that the buttressing

layer of cooler air supports the central blade of hot air as the central blade of hot air flows away from the housing.

Preferably the fan is arranged within an outer fan housing, an inner fan housing containing a motor for rotating the fan, the wings extending from the inner housing to the outer housing, an opening in the inner housing so that air can pass through the opening, a secondary fan within the inner housing for drawing air into the inner housing to flow over the motor to cool the motor, and an outlet for returning the air from the inner housing to the exterior of the inner housing.

This aspect of the invention also provides a body dryer including:

a dryer housing;

heating means in the housing for heating air in the housing;

an outlet aperture for discharge of air from the housing; and

a fan assembly for supplying air to the dryer housing, including:

(a) a primary fan;

(b) an outer fan housing;

(c) an inner fan housing for defining an air chamber with the outer fan housing through which the primary fan can blow air;

(d) a fan motor arranged in the inner fan housing for driving the primary fan;

(e) a secondary fan in the inner fan housing; and

(f) an opening in the inner housing so that air can flow from the chamber through the opening and into the inner housing under the influence of the second fan to cause an air flow over the motor for cooling the motor.

Preferably the dryer housing has an air inlet at a lower portion of the dryer housing, and the fan being disposed adjacent the air inlet for drawing air into the housing, which air can flow over the heating elements and then, due to pressurisation within the housing, exit the outlet aperture in the form of a narrow blade of air which draws the buttressing layer of cooler air, so that the buttressing layer of cooler air supports the central blade of hot air as the central blade of hot air flows away from the dryer housing.

Preferably the dryer includes air flow control means for converting a vortex flow of air created by the fan into a substantially laminar flow of air.

Preferably the air flow control means comprises a pair of wings arranged downstream of the fan, each wing in the pair of wings being curved in a direction generally opposite to one another so that the vortex air flow created by the fan impinges on the wings and is straightened by the wings into a substantially laminar flow of air, which then flows into the dryer housing and over the heating means.

Preferably each heating element comprises a said coil of wire supported on a central insulating strip.

Preferably the heating element includes a plurality of support means arranged along the length of the coiled heating element, for supporting the coils of the coiled heating element to prevent the heating element coils from simply collapsing when the dryer housing is arranged in a vertical disposition for use.

A further aspect of the invention provides a body dryer, including:

an elongate housing defining an air chamber, the elongate housing being intended to be mounted so that the longitudinal axis of the housing is arranged substantially vertically;

an elongate narrow outlet opening extending substantially the entire length of the housing;

a heating element in the housing and extending substantially parallel to the outlet aperture for substantially the entire length of the outlet aperture; and

means for pressurising the housing with air so that the air flows over the housing element and out through the outlet aperture.

Preferably the means for pressurising the housing comprises a fan mounted in a lower portion of the housing, the housing having an air inlet adjacent the fan.

Preferably the length of the housing is about 1500 mm.

Preferably the air outlet aperture comprises a segmented slit extending in the direction of the longitudinal axis of the housing.

Preferably the heating element comprises at least one coiled heating element arranged substantially parallel to the outlet aperture and supported in the housing so that the outlet aperture is spaced from the heating element.

Preferably two coiled heating elements are provided, the coiled heating elements being arranged one behind the other relative to the outlet aperture.

Preferably the dryer includes air flow control means for converting a vortex flow of air created by the fan into a substantially laminar flow of air.

Preferably the air flow control means comprises a pair of wings arranged downstream of the fan, each wing in the pair of wings being curved in a direction generally opposite to one another so that the vortex air flow created by the fan impinges on the wings and is straightened by the wings into a substantially laminar flow of air, which then flows through housing and over the heating means and out through the outlet aperture.

Preferably each heating element comprises a said coil of wire supported on a central insulating strip.

Preferably the heating element includes a plurality of support means arranged along the length of the coiled heating element, for supporting the coiled heating element to prevent the coiled heating element coils from simply collapsing or compacting when the housing is arranged in a vertical disposition for use.

Preferably the fan is arranged within an outer fan housing, an inner fan housing containing a motor for rotating the fan located in the outer housing and spaced from the outer housing, the wings extending from the inner housing to the outer housing, an opening in the inner housing so that air can pass through the opening, a secondary fan within the inner housing for drawing air into the inner housing through the opening to flow over the motor to cool the motor, and an outlet for returning the air from the inner housing to the exterior of the inner housing.

Preferably each support means for supporting the coiled element comprises a first card portion having a profiled edge, a second card portion having a profiled edge, so that when the first card portion and second card portion are brought together, the profiled edges define apertures through which both the coil and the central support strip

can extend, and with the card portions adjacent the apertures forming support surfaces for holding the coiled element to prevent the coiled element from collapsing vertically under its own weight when the body dryer is installed in a vertical position for use.

Preferably the card portions, and therefore the coiled heating element, is supported in a support frame fixed in the housing.

Preferably the support frame comprises a generally U-shaped section in which the card portions and heating element are received, and a lid section for coupling to the U-shaped section and for holding the card portions, and therefore the heating elements within the frame.

Preferably the dryer includes a control panel section, the control panel section comprising at least one light conductor, a interface at one end of the light conductor, against which the user's fingers can locate, so as to change the nature of light reflected from the interface back to the light conductor to thereby provide a control signal for operating the dryer. A further aspect of the invention relates to the manner in which a heating element is supported in the dryer.

This aspect of the invention provides a body dryer including:

a housing defining an air chamber;

an outlet aperture in the housing;

an air blower for supplying air into the housing for discharge through the outlet aperture; and

a heating element supported in the housing for heating the air in the housing prior to discharge of the air through the outlet aperture, the heating element having:

(a) at least one coiled wire supported on a

central strip;

(b) a first card having a profiled edge defining part of a first slot and part of a second slot, and an edge section defining one edge of a transverse slot located between the first and second slots;

(c) a second card having a profiled edge defining second portions of the first and second slots, and a second edge of the transverse slot;

(d) the coiled wire of the heating element and the strip being supported by the first and second cards when the cards are brought into side by side relationship, so that the coiled wire passes through at least one of the first and second slots, and the strip passes through the transverse slot.

Preferably a plurality of said first and second cards are arranged along the length of the coiled heating element to support the coiled heating element.

Preferably two coiled heating elements are supported by each first card and second card in substantially parallel relationship with respect to one another, and wherein the first card has a second profiled edge defining part of a first slot and part of a second slot, and an edge section defining one edge of a transverse slot located between the first and second slots, the second card having a second profiled edge defining second portions of the first and second slots and a second edge of the transverse slot, and wherein one of said two coiled wires passes through one of the first and second slots and the respective strip passes through the transverse slot of the profiled edge defined by the first and second cards, and the other of the coiled wires passes through the first and second slots, and the respective strip passes through the transverse slot of the second profiled edges defined by the first and second

cards.

Preferably the first and second cards are supported by a frame.

Preferably the frame includes a first U-shaped frame section having opposed first and second walls and a base wall joining the first and second walls, and the first card has first and second tabs for engaging in apertures in the first and second walls, and a third tab for engaging in the base wall.

Preferably the frame is completed by a cover and the second card has a tab which engages in an aperture in the cover, and tab which engages in the apertures of the first and second walls of the U-shaped frame.

Preferably at least one of the first and second cards includes a prong on the edge which defines the transverse slot, and the strip includes an opening for receiving the prong for securing the strip and therefore the coiled heating element to the said one of the cards.

Preferably the air blower comprises a fan, the housing having an air inlet at a lower portion of the housing, and the fan being disposed adjacent the air inlet for drawing air into the housing, which air can flow over the heating elements and then, due to pressurisation within the housing, exit the outlet aperture in the form of a narrow blade of air which draws a buttressing layer of cooler air, so that the buttressing layer of cooler air supports the central blade of hot air as the central blade of hot air flows away from the housing.

Preferably the dryer includes air flow control means for converting a vortex flow of air created by the fan into a substantially laminar flow of air.

Preferably the air flow control means comprises a pair of wings arranged downstream of the fan, each wing in the pair of wings being curved in a direction generally opposite to one another so that the vortex air flow created by the fan impinges on the wings and is straightened by the wings into a substantially laminar flow of air, which then flows through housing and over the heating means and out through the outlet aperture.

Preferably the fan is arranged within an outer fan housing, an inner fan housing containing a motor for rotating the fan located in the outer housing and spaced from the outer housing, the wings extending from the inner housing to the outer housing, an opening in the inner housing so that air can pass through the opening, a secondary fan within the inner housing for drawing air into the inner housing through the opening to flow over the motor to cool the motor, and an outlet for returning the air from the inner housing to the exterior of the inner housing.

This aspect of the invention also provides a method of forming a heating element including the steps of:

providing a coiled heating element having a coiled wire and a strip located in the coiled wire for supporting the coiled wire;

providing a first card having a profiled edge defining part of a first slot and part of a second slot, and an edge section defining one edge of a transverse slot located between the first and second slots;

locating the first card in a support member;

locating the coiled wire and the strip relative to the first card so that the coiled wire winds through the one of part of the first slot and the part of the second slot, and the substrate is adjacent the edge defining the transverse slot;

locating a second card having a profiled edge defining second portions of the first and second slots, and a second edge of the transverse slot, so that the part of the first and second slots of the second card register over the coiled wire so the coiled wire coils through one of the first and second slots defined by the first and second cards when the first and second cards are brought together, and the strip is located in the slot defined between the transverse edge portion of the first card and the transverse edge portion of the second card.

Preferably the method includes the step of securing the second card to the support member by a cover member which attaches to the support member.

Preferably the support member comprises a generally U-shaped channel frame member.

A further aspect of the invention relates to the on/off control of the body dryer.

This aspect of the invention may be said to reside in a body dryer including:

a housing defining an air chamber;

an outlet aperture in the housing;

heating means for heating air in the housing;

an air blower for supplying air into the housing for heating by the heating means and for discharge through the outlet aperture;

a light transmitting conductor having a first end forming an on/off control and a second end arranged adjacent a light source for launching light into the light conductor;

a detector at the second end of the light conductor for detecting light reflected from the first end for providing a control signal; and

wherein when a user locates his or her finger on

the first end, the nature of light reflected from the first end back to the second end alters, to thereby change the control signal for turning on or off the dryer.

This aspect of the invention enables control over the dryer without the user having to come into contact with any component or switch of the dryer to which electricity is connected. Thus, the user, likely being wet at the time of operation of the dryer, is insulated from electronic componentry by the light conductor to avoid any possibility of electrocution.

Preferably the light conductor has a first branch along which light travels to the first end from the light source, and a second branch along which light travels after reflection from the first end to the detector.

Preferably the light conductor has a third branch extending between the first and second ends, and a light source at the second end of the third branch which is activated upon operation of the heater so light travels along the third branch to the first end to provide a visual indication of the operation of the dryer.

The invention also provides a fan assembly including:

a fan;

a motor for driving the fan; and

at least one pair of air flow control wings downstream of the fan for converting vortex or rotating flow of air created by the fan into a laminar flow of air.

The invention also provides a fan assembly including:

a primary fan;

an outer fan housing;

an inner fan housing for defining an air chamber with the outer fan housing through which the primary fan can blow air;

a fan motor arranged in the inner fan housing for driving the primary fan;

a secondary fan in the inner fan housing; and

an opening in the inner housing so that air can flow from the chamber through the opening and into the inner housing under the influence of the second fan to cause an air flow over the motor for cooling the motor.

The invention also provides a heating element including:

at least one coiled wire supported on a central strip;

a first card having a profiled edge defining part of a first slot and part of a second slot, and an edge section defining one edge of a transverse slot located between the first and second slots;

a second card having a profiled edge defining second portions of the first and second slots, and a second edge of the transverse slot;

the coiled wire of the heating element and the strip being supported by the first and second cards when the cards are brought into side by side relationship, so that the coiled wire passes through at least one of the first and second slots, and the strip passes through the transverse slot.

Brief Description of the Drawings

Figure 1A is a front view of a body dryer embodying the invention;

Figure 1B is a side view of the dryer of Figure 1A;

Figure 2 is an exploded view of the dryer shown in Figures 1A and 1B;

Figure 3 is a partially assembled view of the body dryer;

Figure 4 is a detailed view of the upper end of the dryer;

Figure 5 is a detailed view of Figure 4 with the outer housing case removed;

Figure 6 is a perspective view of a light conductor used in the preferred embodiment of the invention;

Figure 7 is a view of the other end of the dryer;

Figure 8 is a view of the end of Figure 7 with an end cover and grille removed;

Figure 9A and Figure 9B are views of a grille and end cover respectively;

Figure 10 is a view of the end cover and grille in the assembled condition;

Figure 11 is a detailed view showing the mechanism for mounting the dryer to a wall;

Figure 12 is a view similar to Figure 11 but with the dryer actually mounted on a hook;

Figure 13 is an exploded view of the electronic control section;

Figure 14 is an assembled view of the componentry shown in Figure 13;

Figure 15 is an exploded view of a fan housing used in the dryer of the preferred embodiment;

Figure 16 is a view of the fan housing in an assembled condition;

Figure 17 is a view of the fan housing in an assembled condition, but with part of the inner and outer fan housing removed to show internal detail;

Figure 18 is a view of a heating element used in the preferred embodiment of the invention;

Figure 19 is a side view of the heating element of Figure 18;

Figure 20 shows the disposition of the heating element in the dryer according to the preferred embodiment;

Figures 21A, 21B and 21C show a strip, cover and frame blank used in the assembly of the heating element of the preferred embodiment;

Figures 22A and 22B are drawings illustrating the manner in which the heating assembly is assembled;

Figures 23A, 23B, 23C, 23D and 23E show further detail of the assembly of the heating element of the preferred embodiment;

Figure 24 is a side view of a light conductor used in the control section of the dryer according to the preferred embodiment;

Figure 25 illustrates air flow through the device according to the preferred embodiment of the invention; and

Figure 26 is a cross-sectional view looking down on the dryer showing the nature of air flow from the dryer for drying a person's body.

Detailed Description of the Preferred Embodiment

With reference to Figures 1A and 1B a body dryer 10 is shown which has a housing 11 formed from a rear housing casing 12 and a front housing casing 13. Figure 1B shows the dryer 10 connected to a wall 2, and it will be noted that the dryer is located a distance above floor 4, as illustrated by arrow 3 in Figure 1B.

As is best shown in Figure 2, the rear casing housing 12 is in the form of a slightly dished panel having upstanding edges 14. The front housing casing 13 is in the form of a generally hollowed U-shaped casing having curved side walls 15 and 16 which smoothly merge into a front curved transition region 17.

The top of the housing casing 13 is closed by an upper panel 18 which inclines slightly downward from the free ends of the walls 15 and 16 to curve transition region 17. The bottom of the housing casing 13 is also inclined and defines an air inlet 20 which has a cover grille 21 and filter 22.

The transition region 17 of the housing casing 13 is provided with an elongate aperture 23 which extends for substantially the entire length of the housing casing 13. As noted, the opening 23 terminates short of the air inlet end 20 to define cover section 26 in which motor assembly 27 will locate.

The aperture 23 is provided with a vent strip 28 which has a narrow segmented slot 29 extending for its entire length. The slot 29 is segmented by bridging portions 30 which divide the slot 29 into slot sections 29', as is best seen in Figure 4. However, if desired, the slot 29 could be a continuous slot rather than a segmented slot. A heating element 31 is mounted to the housing casing 11 by brackets 32. The structure and method of assembly of the heating element 31 will be described in more detail hereinafter. The fan housing 27 also mounts to the housing casing 11 by screws 33 which locate through holes 34 in the fan housing 27 and screw into bosses 35 formed in the housing casing 11. The brackets 32 of the heating element 31 also screw into bosses 36 formed on the housing casing 12. The front housing casing 13 attaches to the rear housing casing 12 by screws 37 which screw through bosses 38 and into screwed apertures (not shown) in the front housing casing 13.

Resilient pads 39 may attach to the rear of the housing casing 12 to dampen vibration and also compensate for any services irregularities in the wall 2 to which the dryer is connected.

The dryer 10 is connected to wall 2 shown in Figure 1B (and also in Figure 11) by a hook 40 which is screwed to the wall 2 by screws 41. A labyrinth cover 41 is attached to the rear of the casing housing 12 by screws 42 and provides a cover for securing electrical wiring used in the preferred embodiment. The labyrinth cover 41 also

defines an entrance slot 44 for the hook 40. Hook cover 43 attaches to the rear of the housing casing 12 by screws 44 and provides a recess in which hooked portion 40a of the hook 40 can locate to thereby secure the dryer to the wall 2. The terminal block 47 locates in the housing cover 12 and is closed from the rear by cover 48 which is attached in place by screws 49. The cover 48 allows access of the wiring to the terminal block 22, and covers the wiring so that exposed wires are not accessible from outside the dryer. The cover 41 also provides a cable clamping facility so that the cables will not slide out and provide a hazard if they have not been properly secured into terminal block 47. Electronic control assembly 49 is located in the housing casing 11 just above the location of the terminal block 22 and secured in place by screw 50. A control panel cover 51 locates in a shallow recess 52 in the transition portion 17 of the housing cover 13, and a light conductor assembly 53 extends between the cover 51 and the control assembly 26 to provide on/off control of the dryer, as will be described in more detail hereinafter.

If desired, the dryer can be further secured to the wall by wall screws 77 which screw through bosses 79 (only one shown in Figure 2).

Figure 3 shows the heating element 31 and the fan housing 27 mounted to the rear cover housing 12. This figure also shows the control assembly 49 and the terminal block 47 in place with the light conductor 53 arranged over the control assembly 49.

As shown in Figure 4, control panel badge 51 includes interfaces 54, 55, 56, 57 and 58, which are defined by the first end of light conductor 53, so that by touching the interface 54 or 55 for example, the dryer can be turned on or off by changing the characteristic of the

light which travels through the light conductor 53. This will be described in more detail hereinafter. The fact that the device is switched on or off by this method ensures that the user does not come into contact with any component to which electricity is supplied whilst in a wet condition, thereby avoiding the possibility of electrocution.

Figure 5 is a more detailed view showing the light conductor 53 arranged on the control assembly 49 and also the heating element 31 fixed in the housing casing 12. This figure also shows securing tabs 301 and screw hole 302 which are used to secure the electronic control section shown in Figure 14, which has flats 303 which locate under the tabs 301 and screw 50 which screws into the hole 302.

Figure 6 shows the light conductor 53 in more detail and has a first end formed by the ends 54 to 58, and a second end collectively shown as 60, which is arranged adjacent to the control assembly 49. The light conductor 53 has two branch sections 61 and 62 which are generally identical, and a middle branch section 63a which are all joined by a web 64. The light conductors 61 and 62 are defined by a first branch 63 which extends from end 60 to end 54, a second branch 64 which extends from end 60 to end 54, and a third branch 65 which extends from end 60 to end 54. The middle section 63 is defined by three generally parallel light conductors 66, 67 and 68, which extend from the end 60 to the ends 56, 57 and 58, as shown in Figure 6. The webs 64 have right angled bends which minimise light cross talk between the sections 61, 62 and 63a by reflecting such light substantially back upon itself. The sections 61 and 62 also include collars 55a which snap into recesses in the casing 13 to facilitate securement of the light conductor 53 in place.

The operation of the light conductor 53 will be described in further detail hereinafter.

Figure 7 is a detailed view of the air inlet end 20 at which grille 21 and filter 22 can be plainly seen.

Figure 8 is an end view similar to Figure 7, but with the grille 21 and filter 22 removed so the fan housing 27 is visible within the dryer housing 11. The dryer also includes a microswitch 70a which detects when the grille 21 and filter 22 are in place and, if removed, disables both the heater and the motor so that the heater and motor do not operate.

The filter 22 and grille 21 are shown in detail in Figures 9A and 9B. The grille 21 secures to the filter 22 by locating lugs 68 of the filter into openings in end flange 69 of the grille 21, as is best shown in Figure 10. The lugs 68 act as both hinges and securing clips, and the other end of the grille 21 is secured by a resilient clip, hook and releasing tab 68a, 68b. Thus, the filter 22 can be easily removed from the grille 21 for cleaning or replacement as is necessary.

The grille 21 and filter 22 can be secured in place in the inlet 20 by a snap action, and also further secured by a screw 70 (see Figure 8) which locates through boss 71 in the end flange 69 of the grille 21. The snap fit of the grille 21 is also facilitated by a tongue 72 which snaps into a recess (not shown) in the housing casing 13.

Figure 11 is a more detailed view showing the hook assembly described with reference to Figure 2, which is used to secure the device to a wall 2 as shown in Figure 1. Figure 11 also shows the external cable labyrinth 74 in more detail, in which cables can be laid up the rear of the dryer from a power point or the like to the labyrinth

cover 41 and up through opening 75 which is covered by terminal cover 48 so that the cables can extend into the control assembly 49 located within the housing 11. It can also be seen in this figure that the rear of the casing housing 12 includes a catch 76 which is covered by the hook cover 43, and defines a recess in which the hook portion 40a locates to securely hang the dryer on the hook 40.

Figure 12 is a view similar to Figure 11, but with the dryer shown hooked on the hook 40. Obviously the wall to which the hook 40 is connected is omitted for showing the rear of the housing 12, but sits adjacent the wall when the dryer 10 is connected to the wall 2.

Figures 13 and 14 show an exploded and assembled view of the electronics assembly which includes a diecast metal heat sink 80 and a circuit board 90a which carries electronic componentry for controlling the dryer. As can be seen in Figures 13 and 14, the circuit board 90a secures to the heat sink 80 by screws 81 and 82, and the heat sink 80 and the circuit board 90 screw to the housing casing 12 by the screw 50. The board 90 is secured to the heat sink 80 by screws which are received in recesses 305 and 306 and screw into holes 304 (only one shown) on the board 90.

Figure 15 is an exploded view of the fan assembly 27 previously described. The fan assembly 27 comprises an outer fan housing 90 which is generally cylindrical in configuration. The housing 90 includes feet 34 which receive the screws 33.

The housing 90 has a pair of grooves 91 which extend from the end of the housing 90 remote from the inlet end 20. An inner fan housing 94 is formed from two housing parts 95 and 96 which are generally mirror images with respect

to one another. The housing parts 95 and 96 each have a part cylindrical section 97 and a first wing part 98 and a second wing part 99. The wing parts 98 and 99 each have a flange 100 so that when the casing parts 95 and 96 are joined together, the semi-tubular flange parts 100' form a pair of complete tubular flanges 100 which locate in respective grooves 91 in the outer housing 90 to thereby secure the inner housing 94 within the outer housing 90. The housing 94 is fixed by screws 120 which locate in tubular flanges 100 and screw into housing 90, as illustrated in Figure 17.

As can be seen in Figure 15, the wings 98 and 99 are curved in opposite directions with respect to one another.

A fan motor 102 is formed by an armature 103 and field windings 104. The armature 103 has an output shaft 105 onto which is coupled a primary fan 106. The primary fan 106 sits outside the inner housing 94, as is best shown in Figure 16.

The two inner housing parts 95 and 96 are joined together by screws 107 (only one shown). A secondary fan 108 is also mounted on the shaft 105, but is located within the inner housing 94.

The motor 102 also has brushes 109, an armature magnet 110, crinkle washer 111 and motor electronics 112.

The inner housing 94 has an opening 112. When the motor 102 is operated and the fan 106 is rotated, air is drawn through the inlet opening 20 via the grille 21 and filter 22 and flows in the generally annular chamber defined between the inner fan housing 94 and the outer fan housing 90. The fan 106 generally creates a vortex or spiral air flow which is directed into the annular chamber. The wings 98 and 99 which are curved in opposite directions

with respect to one another tend to cause that vortex flow of air to be streamlined into a laminar flow of air which then moves into the housing 11 to fill the chamber defined within the housing 11 between the housing cases 12 and 13 in which the heating element 31 is located. The laminar air flow therefore creates a good streamlined flow of air over the heating element 31 throughout the entire length of the housing 11 for discharge from the outlet aperture 29. When the fan is operated, the fan 108 is also rotated to draw into the inner housing through the opening 112 so that the air flows over the motor 102 mounted within the inner fan housing 94 to cool the motor 102 and also the motor control electronics 52. The air leaves the inner housing 94 via opening 113, so as to again be directed by the fan 106 through the annular chamber defined between the inner housing 94 and the outer housing 90. Thus, the air which is circulated through the opening 112 and the inner housing 94 serves to cool the motor 102 and its control electronics 52, which may otherwise overheat due to the containment of the motor within the relatively tight confines of the inner housing 94.

It should be noted that the air flow which leaves the fan 106 is a vortex light flow of air, as is explained above, which extends at about 45° at the outer edges of the housing 90 with respect to the longitudinal axis of the housing 90. The wings 98 and 99 are preferably curved, as also explained, so that they intercept the air flow in substantially parallel fashion to the direction of air flow so that the air flow is converted from the vortex flow into the laminar flow very smoothly by flowing over the wings 98 and 99 and then being straightened by the wings 98 and 99. This efficiently converts the air flow to a laminar flow and prevents turbulence from being created as the vortex flow of air engages the wings 98 and 99.

Heating element 31 is shown in more detail in Figure 18. The heating element 31 comprises a frame 121 which supports two coiled heating elements 122 and 123. Power is supplied to the elements 121 and 122 via power leads 124, which extend from controller 49. Power is supplied to the controller 49 from a normal electrical lead from a wall mounted plug, and the controller 49 controls the supply of power to the heating element 31 and also to the electronic controller 112 of the fan assembly 27.

The frame 121 is formed from a generally U-shaped frame section 121a and a cover 121b. A plurality of supports 127 are supported in the cover 121 and each of the supports 127 comprises a first card 129 and a second card 130, which will be described in more detail hereinafter. The coiled heating elements 122 and 123 are supported on a strip 131 of insulating material such as micanite. The cards 129 and 130 are formed from the same insulating material so that the coiled heating elements 123 and 122 are insulated from the support frame 121. Support frame 121 may be stamped from metal, as will be described in more detail hereinafter.

Figure 20 is a transverse cross-section through the body dryer of the preferred embodiment, and shows the disposition of the heating element 31 in the housing. As is apparent from Figure 20, the heating unit 31 is aligned in the housing so that the heating elements 122 and 123 extend substantially parallel with the slot 29 and with the element 123 arranged immediately behind the element 122 with respect to the slot 29.

Figures 21A, 21B and 21C show the strip 131 and stamp metal blanks from which the housing 121 is formed. As is apparent from Figure 21A, strip 131 is an elongate thin strip and a hole 140 is provided at one end of the strip 131. Cover 121b is stamped from metal and has side rails

141 and 142 and crossbars 143. The crossbars 143 are provided with a slot 145 and locking slots 146 are provided in the crossbars 141 and 142 adjacent the bars 143. A slot 143 is also provided in end plate 147 of the cover 121b.

The frame section 121a is stamped from metal and comprises rails 147 which are joined by crossbars 148. The crossbars 148 are provided with a slot 149. The rails 147 also have crossbars 150 which are provided with open ended slots 152. The bars 150 are joined by rails 153. The blank shown in Figure 21C is bent at the reduced thickness portions 155 of the crossbars 148 to form a U-shaped configuration with the bars 150 and rails 153 forming side walls 160 and 161, and the crossbars 148 forming a base wall 162. The bent configuration of the blank in Figure 21C is best shown in Figures 22A and 22B.

The heating coils 122 and 123 are supported by cards 129 and 130 previously described. The cards 129 and 130 are shown in Figures 22A, 22B and also Figures 23A to 23E. The cards 129 and 130 are effectively a mirror image with respect to one another, and therefore only the card 129 will be described. The card 129 has an end tab 160 and upper and lower tabs 161 and 162. The card 129 also is provided with edge profiles 163 and 164 which, once again, are the same. The edge profile 163 will therefore be described. The profile 163 has, in the orientation shown in Figure 22A, a wall 165 and a spaced wall 166 which define the first part of a first slot 167. The first part of a second slot 168 is defined by wall 169 and 170, which will form one edge of a transverse slot which is defined when the cards 129 and 130 are brought together, as will be described in more detail hereinafter. As previously mentioned, the edge profile 164 is the same as the edge profile 163, and the second card 130 is the same as the card 129 except a mirror image.

As is shown in Figures 22a and 22b, the wire heating coils are assembled on insulating strips 131. Figure 22A shows the wires 122 and 123 and the strips 131 separate, and Figure 22B shows them in the assembled configuration. Usually, the heating coils 123 will be provided as a completed product in the assembled state, as shown in Figure 22B. The insulating strips 131 are formed from micanite and serve to support the coiled wires 122 and 123 and prevent lateral movement of the coiled wires 122 and 123.

In order to assemble the heating element 131, the card 130 is located in frame section 121a, as shown in Figure 22B, so that the tab 160 registers in slot 149 of one of the crossbars 148. The tabs 161 and 162 locate in the open ended slots 152 of the walls 160 and 161. This assembly is easily achieved by simply sliding the card 130 in the direction of arrow A in Figure 22A so that it registers in the respective slots. Obviously, a separate card 130 is provided for each of the crossbars 148 and the adjacent crossbars 150 of the frame section 121A.

The card 129 can be arranged on cover frame section 121B by locating its tab 160 through slot 145 in crossbar 143 of the cover frame section 121b. Once again, one card is arranged in each of the slots 143 of the cover 121b.

The cards 129 and 130 shown in Figures 22A and 22B are intended to be the supports for the uppermost portion of the heating wires 122 and 123 when the dryer 10 is arranged vertically, and therefore are provided with prongs 179 on the edges 173. The prongs 179 locate in the hole 140 of the strips 131 so as to securely lock the strip 131 to the cards 129 and 130 shown in Figures 23A and 23B.

The heating element is assembled by moving the heating coils 122 and 123, as shown in Figure 22B, in the direction of arrow B so that they locate in the slots 167 and 170 and the prong 179 passes into the hole 140. The other card 160 is then moved in the direction of arrow B so that the tab 161 and the tab 162 slide into the open ended grooves 150, and the cards overlap, as is best shown in Figures 23A and 23B. In this configuration, as is shown in Figure 23A, the slots 167 and 170 are fully formed and defined by the two path slots formed in each of the cards 129 and 130. Also, the transverse slot 180, which is defined by the edges 173 of the cards 129 and 130, is formed and extends between the slots 167 and 170. In Figure 23A, the prongs 179 are shown.

Figure 23B shows the coils 122 and 123 in position, as well as the strips 131. As is apparent, the coils 122 and 123 simply wind through one of the slots 167 and 170 of each of the respective pairs of cards supported in the frame 122, and the strip 131 extends through the slots 180 of each of the pairs of cards. Thus, when the heater is arranged in the vertical orientation, the coils of the heater are supported by each of the pairs of cards by the coils resting on the regions 190 of the cards adjacent the slots 167 and 170, and with the slots 180 accommodating the strip 131. Thus, the coils are supported when in the vertical position and simply do not collapse or sink down onto one another, but rather remain in the coiled configuration, as is shown in Figure 18 and Figure 19.

After the card 129 is located in place, together with cover 121b, the ends 181 of the crossbars 150 which define the slots 152, project through the slots 146 in the cover 121b. Those ends are then bent around, as shown in Figure 23B, to lock the cover 121B in place and also secure the cards 129 and 130 in place within the frame 121. Thus, the heating element 31 is formed and the coils 122 and 123

stably supported for orientation in a vertical configuration without fear of the coils collapsing or sinking down onto one another, which would greatly impair the heating ability of the heating element 31.

Figures 23C, 23D and 23E show the card pairs below the top pair of cards which include the prongs 179 and which register in the holes 140 of the strips 131. These cards are identical to those previously described, except the prongs 179 are not included.

Although Figure 22B shows the card 160 mounted to the cover 121B, obviously the cards 160 could be inserted in place into the frame section 121A before the cover 120B is located in place on the frame section 121A and also on the tabs 160 of the cards 129.

The structure of the heating element 31 previously described, in which a plurality of the support card pairs 129 and 130 support the coiled wires 122 and 123 along the length of the heating element services to prevent lateral movement of the wires 123 and the strip 131, which in turn prevents fracturing of the strip 131, for shortening of the strip 131 causing the release of one end of the strip 131, and contact of the coiled wires 122 and 123 with either the support frame or other structure which may otherwise cause burning or electrical hazards.

Figure 24 is a view of the light conductor 53 previously described in side view in which only one of the sets of branches 63, 64 and 65 are shown.

As is apparent from Figure 24, circuit board 90 carries first light emitting diode 200 and a second light emitting diode 201. A light detector 202 is also mounted on the board 37. Light from the diode 200 is launched into branch 63 and is transmitted to interface 54 where the

light is reflected from the interface 54 and travels down branch 64 for detection by light detector 202. If a user places his finger 203 on the interface 54, the nature of the reflected light from the interface 54 changes, and the change in the reflected light creates a change in control signal provided by the light which is detected by the detector 202, which, for example, can turn the dryer on so as to supply power to both the fan assembly 27 and the heater element 31. When the detector 202 detects the signal to turn the dryer on, diode 201 can be powered to launch light into branch 65 which can provide a coloured light at the interface 54 to indicate that the dryer is on. The other end of the light 62 (see Figure 6) of the light conductor 53 operates in the same way and can be used to turn the dryer off. The light supplied by the diode 200 is encoded infrared light to prevent accidental operation in case spurious light should enter the light conductor and be received by the detector 202. This arrangement has the advantage that when the operator touches the dryer to turn the dryer on or turn the dryer off, the operator does not touch any part of the dryer to which electricity is conducted. This is important because the user will normally be wet when wishing to operate the device, and therefore, contact with any part to which electricity is supplied may be dangerous and possibly cause electrocution. The use of the light conductor 53 ensures that the control signals to turn the dryer on and off are by way of light signals, and not electrical signals, and therefore there is no contact with any electrically powered part by the user.

Furtherstill and with reference to Figure 24, the section 61 of the light conductor 53 is used, for example, to turn both the heater and the fan on and the heater and fan off. The other branch 62 can be used to turn only the fan on. Thus, when the user locates his or her finger on the interface 54, both the heater and the fan are activated.

When the user locates his or her finger on the interface 55, only the fan is activated. This enables the dryer to be used in hot conditions if desired, so that ambient air is directed onto the user without any additional heating by the heater. The heater and/or fan can be turned off by relocating the user's finger onto the interface 54 or 55, or simply can be timed out by a timer (not shown). Preferably the heater and fan are activated in such a manner that the fan initially is caused to operate at very low speed so that very low air flow is created over the heating element until the heating element fully heats up, and then the fan gradually increases in speed to its full operating speed so that a cold blast of air is not initially provided to the user before the heating element heats up when the dryer is initially activated. Furthermore, when the heater is turned off, the fan is slowed down gradually to prevent the build up of a hot pocket of air in the top of the housing 11 which may damage or impair operation of electronic components located in that part of the housing. Thus, this enables hot air to be purged out of the heater by the fan even after the heater is turned off as the heating element cools down after switch off.

Figures 25 and 26 illustrate the air flow through the device and out of the device to dry a user. As is apparent from Figure 25, air is drawn in inlet end 20 by the fan assembly 27, and the air is produced from the fan assembly 27 as a substantially laminar flow, as shown by arrow C. The air flows up and over the heating element 31 in the housing 11 and then, as the entry of the housing 11 becomes slightly pressurised, is forced out through the slot 29, as shown by arrows D. The flow of air out through the slot 29 is in the form of a narrow blade of air, as shown by arrow E, which is confined within a buttress of colder air. As the narrow blade of air comes into contact with a person's body 250, the air envelopes

around the body, as shown by arrows F, drawing the hot thin blanket of air around the user's body. The thin hot blanket of air which surrounds the user's body, and the cold buttress of air which is outside the heated thin blanket of air, performs extremely good heat exchange from the user so as to remove moisture from the user 250 and therefore dry the user. Obviously the user turns around in front of the air flow so that the entire body is dried.

As is shown in Figure 26, the pressurised air within the housing 11 flows towards outlet 29 and through the outlet 29 in the form of a thin blade. The flow of air is generally between the right angled region defined between the arrows 331 and 332. The air immediately outside those arrows generally does not move at all. The flow of air within the arrow 331 and 332 is defined by an extremely hot air flow in the region 330 which passes directly over the heating elements 122 and 123 previously described, and a colder air flow in the regions 333 and 334 which generally do not pass directly over the heating elements. Thus, the air which leaves the dryer is in the form of a hot blade of air which is surrounded by a buttress of cold air which is also drawn from inside the housing 11. As that flow of air leaves the housing, as shown by the arrows D, the hot blade of air E surrounds the user's body 250 and is entrained within the cooler flow of air shown by arrows G. This flow of air draws a still further buttressing flow of air, as shown by arrows H in Figure 26 from outside the housing 11. Thus, the air flow created by the dryer exits the outlet aperture 29 in the form of a narrow blade of hot air within an envelope of cooler air that is also drawn from within the housing 11. That flow of air then draws a further layer of buttressing cool external air from outside the housing. Thus, a hot layer of air surrounds the user's body 250, ensuring very good heat exchange between the user's body and the hot air to dry the user's body. The nature of the flow created in

the manner referred to above also ensures that the flow of air is generally directed over the user's body in close proximity and does not simply bounce off or be reflected from the user's body in a turbulent fashion. This also facilitates the drying effect of the dryer because of the warm air flow over the user's body, as shown by the arrow F.

The curved shape of the front cover 13 of the housing 11 has little effect on the nature of the air flow out of the housing through the slot 29. However, the curved flow facilitates the entrainment of the buttressing flow of air, as shown by the arrows H, to maintain the smooth flow pattern shown in Figure 26 without the creation of turbulence or the like, which would tend to cause the hot air to mix with cooler air and therefore be drastically cooled before it arrives over the user's body. The creation of turbulence will also impair the smooth flow of air over the user's body which in turn would greatly decrease the drying effect.

The fan assembly and the heating element previously described, whilst having obvious application in the body dryer of the preferred embodiment, are also applicable to other environments in which heated air and air flow characteristics are required. Such applications include vertical oriented space heaters which are currently not achievable in any significant length with open wire heating elements because the elements tend to collapse upon themselves. However, the heating element of the present invention prevents this from happening, and therefore makes vertically oriented space heaters using such open wire heating elements feasible. The heating element may also be used in air curtains used in supermarket entrances and other applications to improve the efficiency by having the heated air near the exit point, thus avoiding wasted energy and heating air which

is supplied from a significant distance from the location of the air curtain. The fan assembly can also be used in any actual flow fan application, as it increases efficiency by converting rotational air vortex energy into pressure.